SGRT on the Halcyon: Faster and more precise?

Patient Positioning Times and Deviations using AlignRT InBore on the Halcyon Linac

Dr. rer. nat. Niels Götting

MVZ Prüner Gang, Flensburg, Germany

KOMPETENZZENTRUM STRAHLENTHERAPIE

www.mvz.sh

PRÜNER GANG Medizinisches Versorgungszentrum

oyora GROUP

Investigation of Patient Positioning Times with / without SGRT

- Introduction of SGRT on the Halcyon Linac: **VisionRT – AlignRT InBore**
- Measurement of Patient Positioning Times before SGRT
- Implementation of an SGRT workflow
  incl. elimination of all skin markers: **VisionRT - „Markerless Award“**
- Measurement of Patient Positioning Times using SGRT
- Investigation of the results

About Us

MVZ Prüner Gang:

Site Flensburg Citti-Park:

Varian-Halcyon with VisionRT / AlignRT

GE Revolution Apex CT
with VisionRT / SimRT

<u>Team:</u>
2 Physicians, 2 Physicists, 4 RTTs

About Us

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Our Way with SGRT

August 2024:

Start of SGRT

with

AlignRT & SimRT

March 2024:

Opening Ceremony,
Flensburg, Citti-Park
(department inside a
shopping mall!)

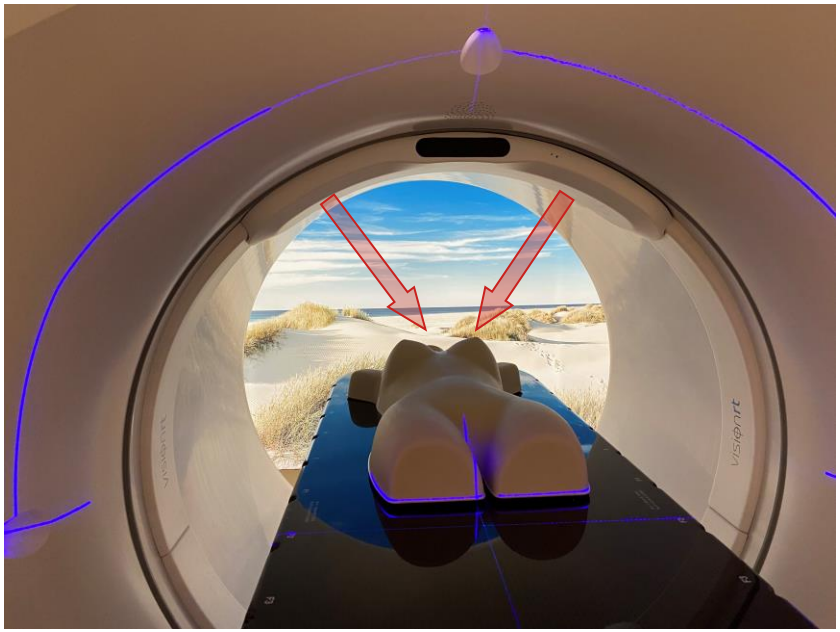
May 2025:

VisionRT Award

Markerless Radiotherapy

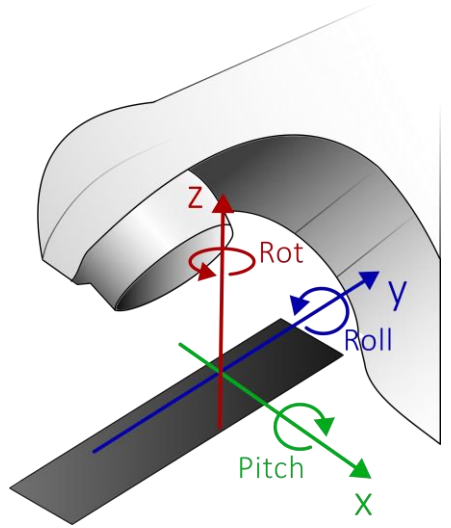
AlignRT on the Varian Halcyon Linac

Setup Position



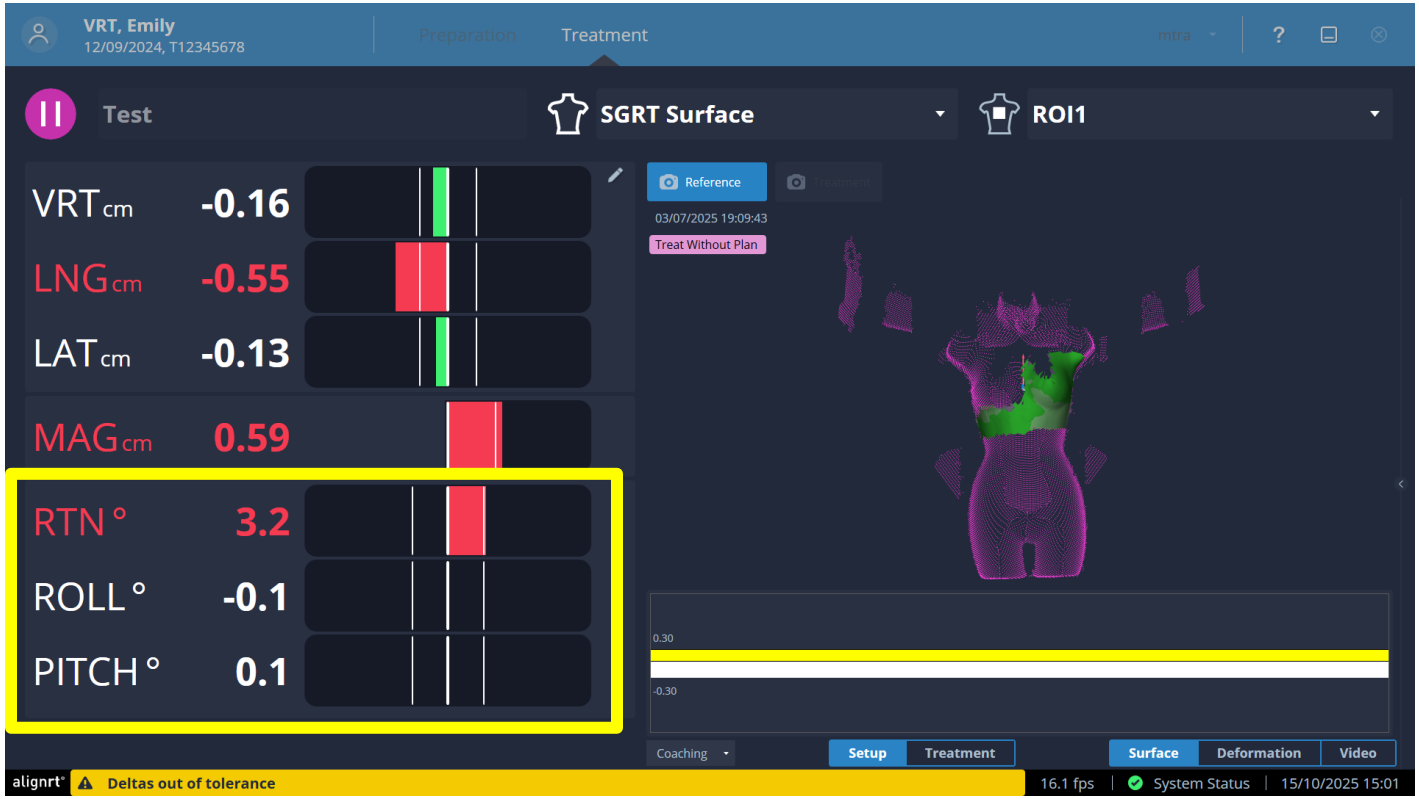
Treatment Position (AlignRT InBore)

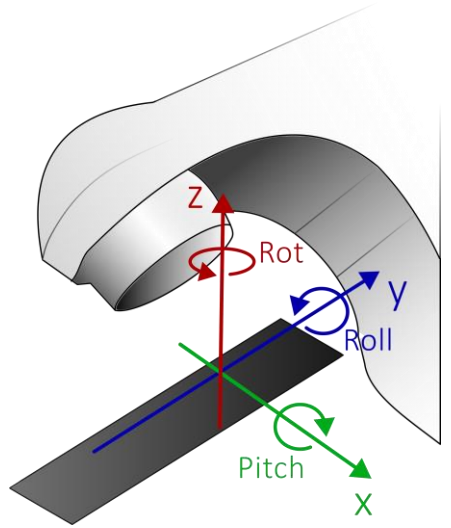
Halcyon: 3D Couch only!



Source: Medizinphysik-Wiki

Halcyon: Rotations → AlignRT!





Source: Medizinphysik-Wiki

Measurement of Patient Positioning Times

Definition of the Positioning Time

- Patient lays down on the couch
  → time for individual adjustment if needed
- Start: Pressing the „Setup“ Button
  → standardized starting point
- End: Pressing the “Load“ Button
  → standardized stopping point

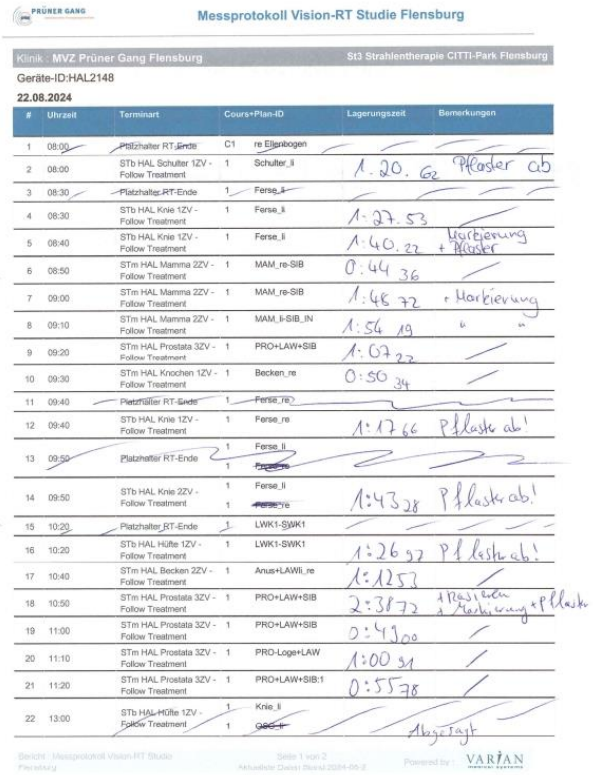
Measured positioning times are comparable!

Reasons for the Selection of Start and Stop Points

- Starting Point not earlier:
  → way to the couch depends on the patient
- Stopping Point not later:
  → (mandatory) IGRT is not of interest
- only 1 RTT needed during these points:
  → second RTT is available for measurement
- Measurement time is written down outside of the bunker

Measured positioning times are comparable!

Working on Paper: Protocol of Time Measurements



PRÜNER GANG

Messprotokoll Vision-RT Studie Flensburg

Klinik: MVZ Prüner Gang Flensburg — St3 Strahlentherapie CITTI-Park Flensburg

Geräte-ID:HAL2148

22.08.2024

#	Uhrzeit	Terminart	Cours+Plan-ID		Lagerungszeit	Bemerkungen
1	08:00	~~Platzhalter RT-Ende~~	C1	re Ellenbogen		
2	08:00	STb HAL Schulter 1ZV - Follow Treatment	1	Schulter_li	1.20.62	Pflaster ab
3	08:30	~~Platzhalter RT-Ende~~	1	Ferse_li		
4	08:30	STb HAL Knie 1ZV - Follow Treatment	1	Ferse_li	1:27.53	
5	08:40	STb HAL Knie 1ZV - Follow Treatment	1	Ferse_li	1:40.22	Markierung + Pflaster
6	08:50	STm HAL Mamma 2ZV - Follow Treatment	1	MAM_re-SIB	0:44 36	
7	09:00	STm HAL Mamma 2ZV - Follow Treatment	1	MAM_re-SIB	1:48 72	+ Markierung
8	09:10	STm HAL Mamma 2ZV - Follow Treatment	1	MAM_li-SIB_IN	1:54 19	" "
9	09:20	STm HAL Prostata 3ZV - Follow Treatment	1	PRO+LAW+SIB	1:07 22	
10	09:30	STm HAL Knochen 1ZV - Follow Treatment	1	Becken_re	0:50 34	
11	09:40	~~Platzhalter RT-Ende~~	1	~~Ferse_re~~		
12	09:40	STb HAL Knie 1ZV - Follow Treatment	1	Ferse_re	1:17 66	Pflaste ab!
13	09:50	Platzhalter RT-Ende	1 1	Ferse_li ~~Ferse_re~~		
14	09:50	STb HAL Knie 2ZV - Follow Treatment	1 1	Ferse_li ~~Ferse_re~~	1:43 38	Pflaster ab!
15	10:20	~~Platzhalter RT-Ende~~	1	LWK1-SWK1		
16	10:20	STb HAL Hüfte 1ZV - Follow Treatment	1	LWK1-SWK1	1:26 92	Pflaste ab!
17	10:40	STm HAL Becken 2ZV - Follow Treatment	1	Anus+LAWli_re	1:12 53	
18	10:50	STm HAL Prostata 3ZV - Follow Treatment	1	PRO+LAW+SIB	2:38 72	+ Markierung + Pflaste
19	11:00	STm HAL Prostata 3ZV - Follow Treatment	1	PRO+LAW+SIB	0:49 00	
20	11:10	STm HAL Prostata 3ZV - Follow Treatment	1	PRO-Loge+LAW	1:00 91	
21	11:20	STm HAL Prostata 3ZV - Follow Treatment	1	PRO+LAW+SIB;1	0:55 78	
22	13:00	STb HAL Hüfte 1ZV - Follow Treatment	1 1	Knie_li ~~OSC-1~~		Abgetagt

Powered by VARIAN

- anonymized:

  date, time of day, type of appointment, region of body, measured duration (stopwatch), remarks

- Examples of Remarks:

  e. g. renewal of skin marks / plasters (before SGRT), difficult / nervous patients, bolus material, ...

- Measured Times and Remarks handwritten:

  fastest way for the RTTs!

Very feasible Method!

Measurements without / with SGRT: Data Set

	without SGRT	with SGRT
Time Interval	24.06.2024 to 26.08.2024 (45 days)	11.04.2025 to 15.05.2025 (22 days – to be continued)
Number of Fractions	717	408
Region of Body	Chest (Mamma), Pelvis (Prostate), Extremities (Knee + Foot), (Abdomen)	Chest (Mamma), Pelvis (Prostate), Extremities (Knee + Foot), (Head)

Database for Analysis (to be continued)

Positioning Times: Statistics

Number of Fraktions	without SGRT	with SGRT	total
Chest	259	217	**476**
Pelvis	298	115	**413**
Extremities (Knee + Foot)	151	59	**210**

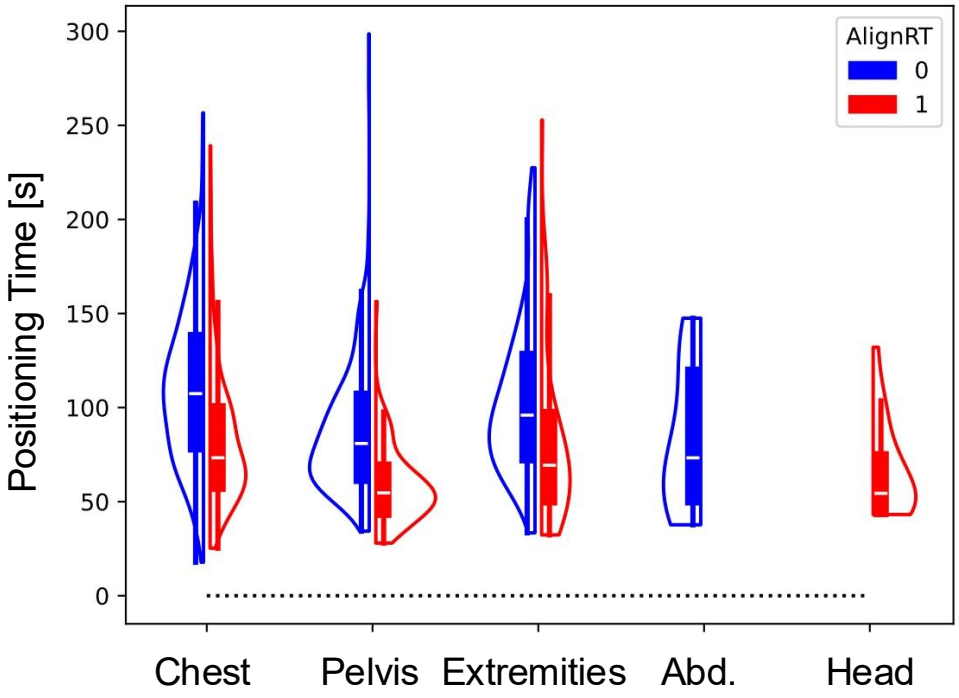
Adequate Statistics for Analysis:
1099 single measurements

Positioning Times: Statistics

Number of Fraktions	total
	476
	413
	210

Special thanks to Annika, Jasmin, Renée, and Sina for 1099 single measurements!

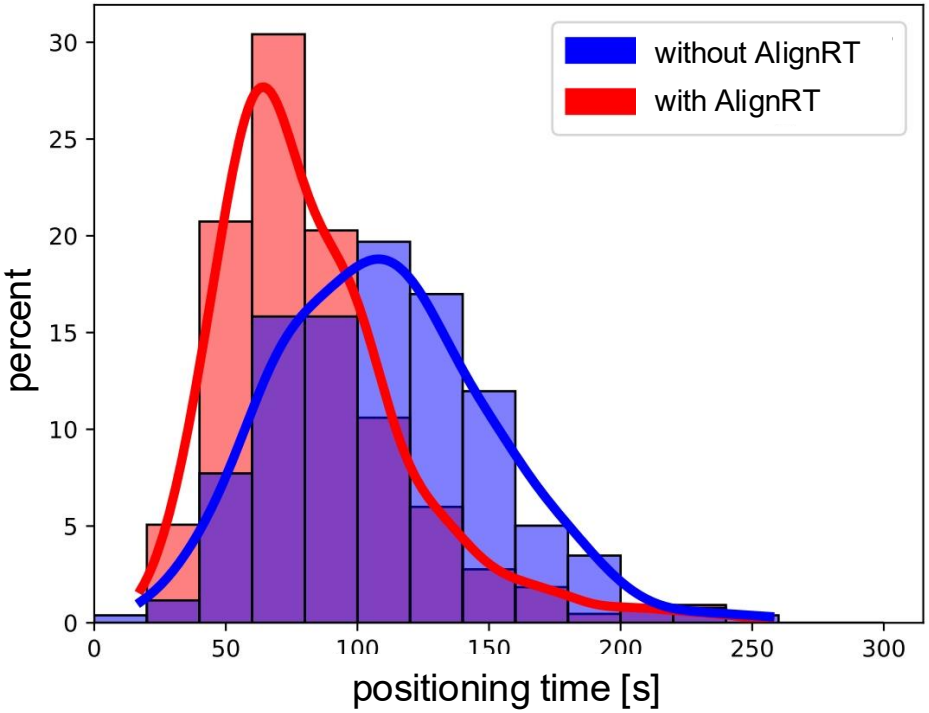
Distribution of Positioning Times



- Chest, Pelvis, Extremities:
  Trend to smaller positioning times with SGRT (AlignRT) visible
- Abdomen / Head:
  no corresponding data sets without / with SGRT (to be ignored here)

Promising Trends!

Distribution of Positioning Times: Chest



- statistical Significance:

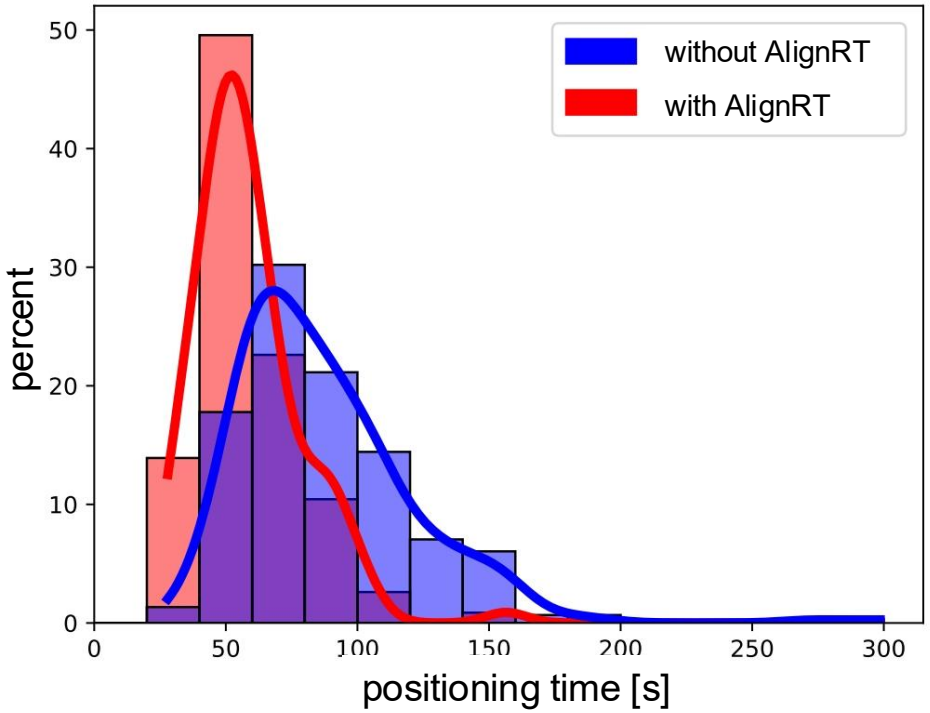
  $p \approx 6{,}9 * 10^{-17}$
  (distributions differ)

- Difference:

  $\Delta t = (28 \pm 5)$ seconds (mean)
  $\Delta t = (34 \pm 7)$ seconds (median)

Positioning with SGRT is faster!

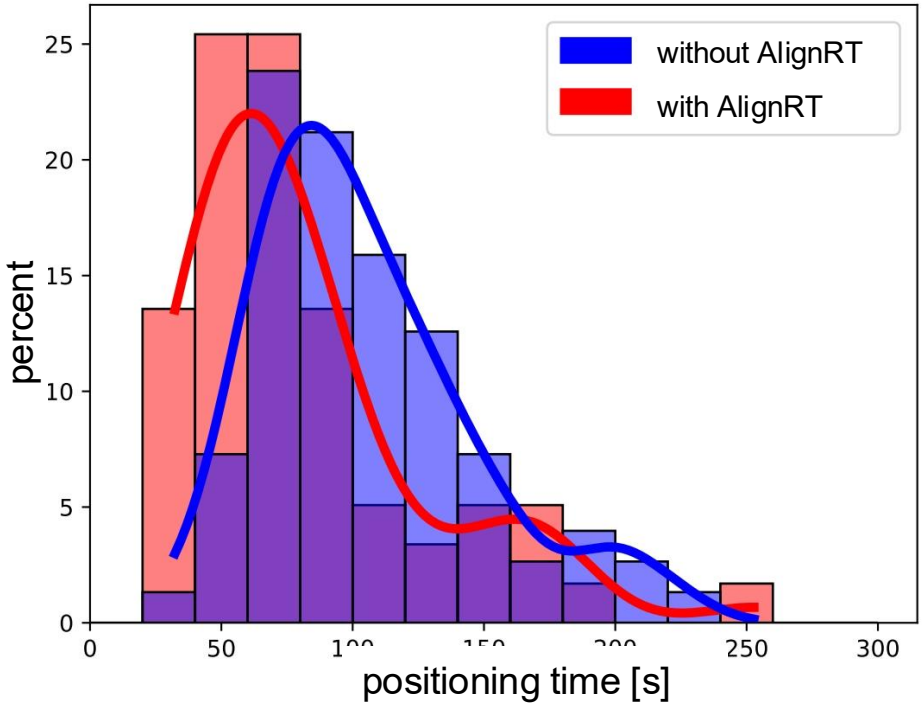
Distribution of Positioning Times: Pelvis



- statistical Significance:
  $p \approx 3{,}8 * 10^{-23}$
  (distributions differ)
- Difference:
  $\Delta t = (29 \pm 4)$ seconds (mean)
  $\Delta t = (26 \pm 5)$ seconds (median)

Positioning with SGRT is faster!

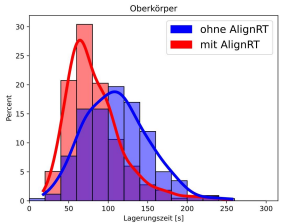
Distribution of Positioning Times: Extremities

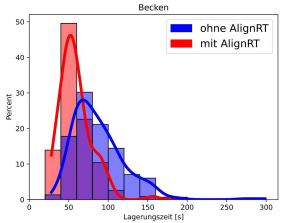


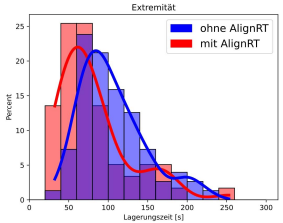
- statistical Significance:
  $p \approx 6{,}3 * 10^{-6}$
  (distributions differ)
- Difference:
  $\Delta t = (23 \pm 10)$ seconds (mean)
  $\Delta t = (27 \pm 12)$ seconds (median)

Positioning with SGRT is faster!

Development of Positioning Times







Reasons for Positioning Times > 2 Minutes:

- renewal of skin marks / plasters (non-SGRT only)
- heavy patients (difficult to move)
- complicated / nervous patients (time to talk needed)
- setting up bolus material

It is always worth to look on these cases!

Positioning Times: Time Differences

Pos. Times (mean values)	without SGRT	with SGRT	Time Differences (mean values)
Chest	111 s	83 s	**(28 ± 5) s**
Pelvis	88 s	59 s	**(29 ± 4) s**
Extremities (Knee + Foot)	105 s	82 s	**(23 ± 10) s**

Considerably faster with SGRT!

Investigation of Position Accuracy without / with SGRT

Varian Halcyon Linear Accelerator:

- imaging (CBCT) is mandatory for every fraction
  → database for investigations

- "Online Match": Performed at the machine's console
  → translation corrections only (3D couch)

- "Offline Match": Performed in the offices (ARIA / OfflineReview)
  → 6D corrections (including rotation, roll, and pitch)

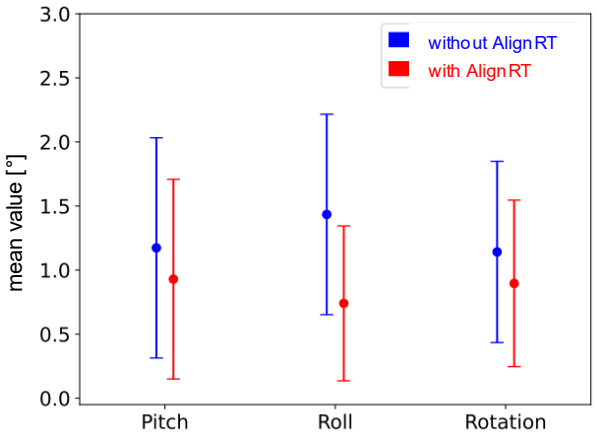
→ Investigation of (absolute) corrections values possible!

Investigation of Position Accuracy: Data Set

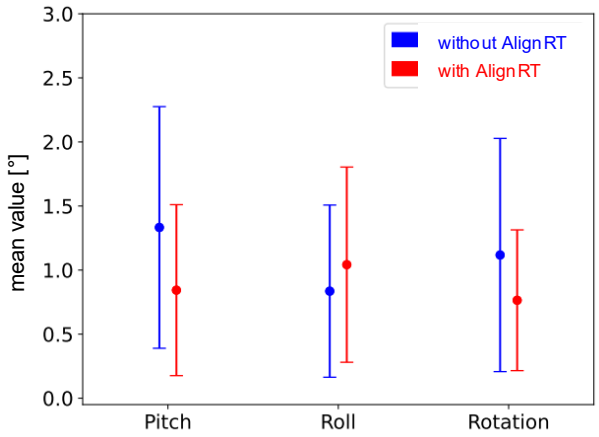
Region	Number of Patients	
	without SGRT	with SGRT
Prostate	10	10
Brest left (DIBH)	4	10
Breast right	8	10
Sum of Fractions	**654**	**882**

→ 1536 fractions: (abs.) deviations from Planning CT determined

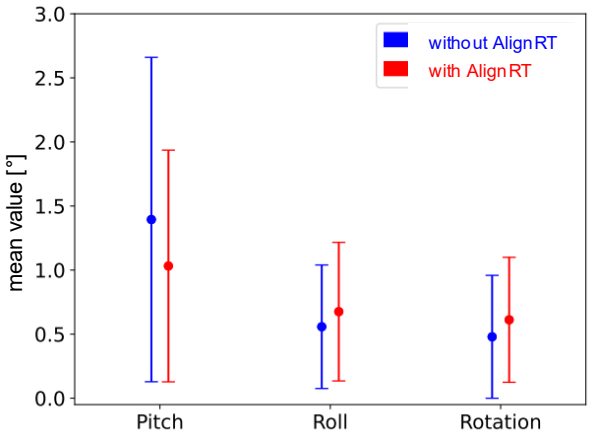
Position Accuracy: Rotations in ARIA / OfflineReview



left Breast (DIBH)



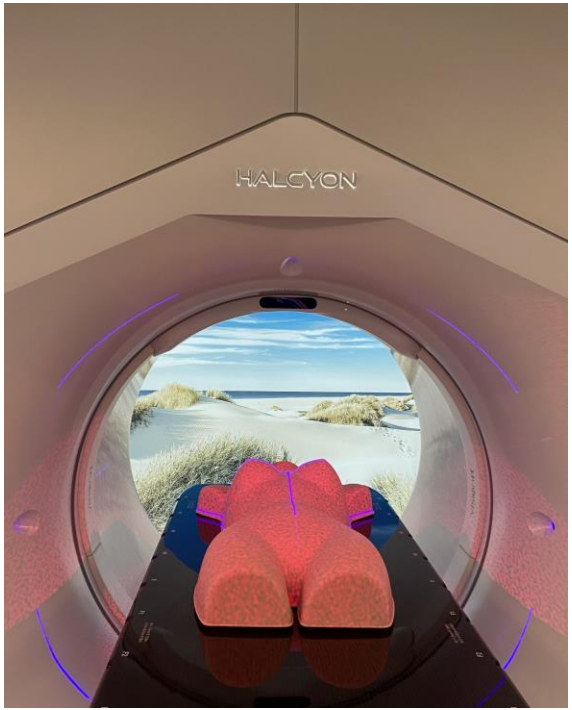
right Breast



Prostate

→ Some Trend to smaller deviations visible (investigations ongoing)

Summary: Positioning Accuracy without / with SGRT



- Forget about Skin Marks:

  lots of time saved;
  no trouble for patients anymore

- Translations (3D Couch):

  less corrections → even more time saved

- Rotations (residual deviations):

  better positioning accuracy

Win-Win Situation
for Patients and Department

Summary: Positioning Times without / with SGRT

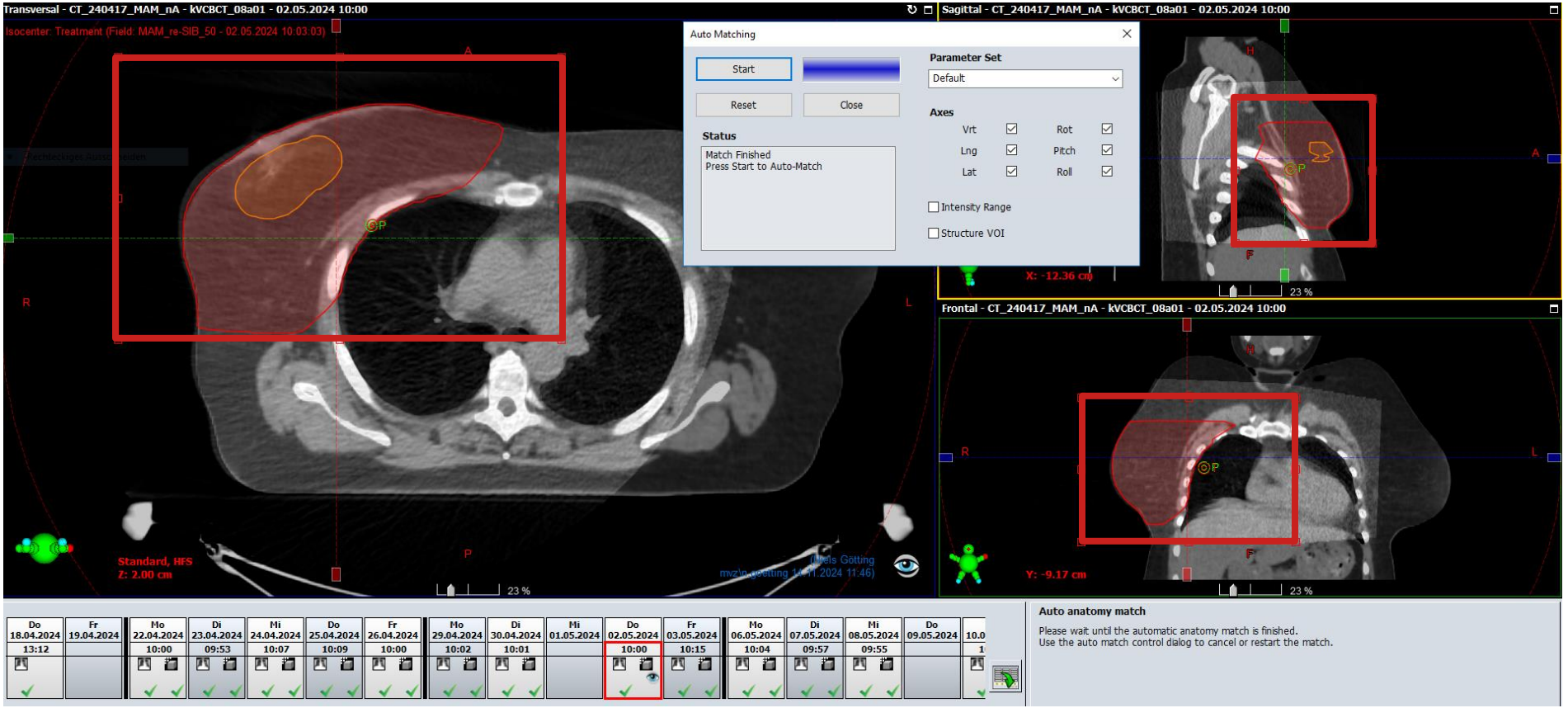
- Measurements of Positioning Times without / with SGRT (AlignRT InBore)
- specific start / end points: Stoppwatch
- 2 Datasets: before / after introduction of AlignRT InBore on Halcyon
- with SGRT: markerless radiotherapy (substantial time savings)
- with SGRT: acceleration of positioning (+ better accuracy)

With SGRT: positioning faster by ca. 25 bis 30 seconds!

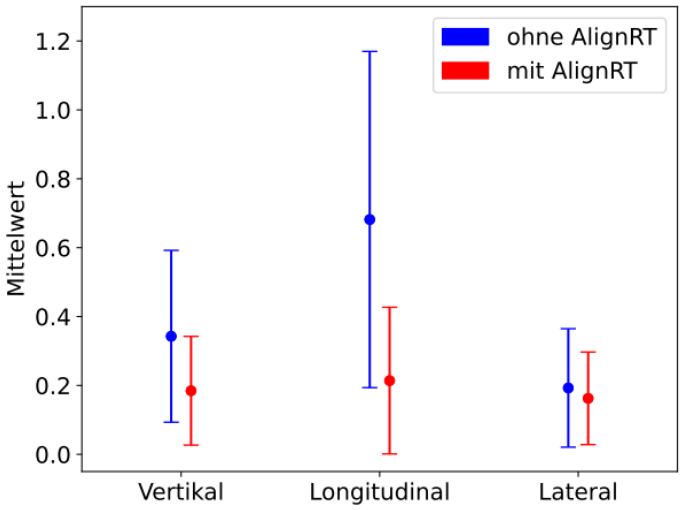
→ Explicit Advantage for Patients and Department! (Win-Win)

Backup Pages

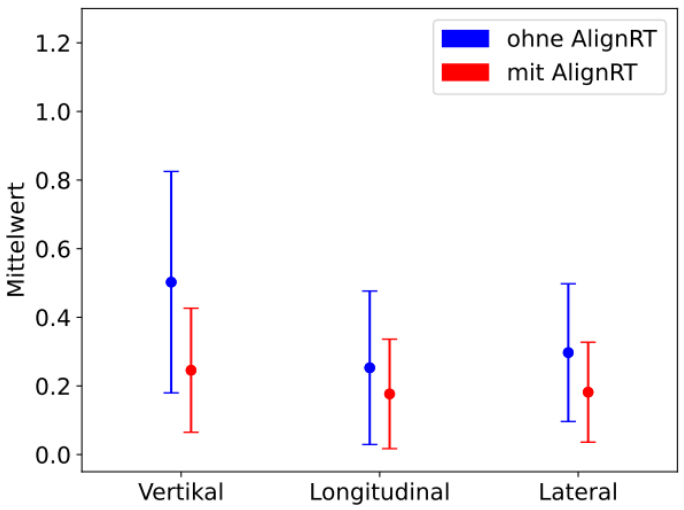
Positioning Accuracy - Methodology



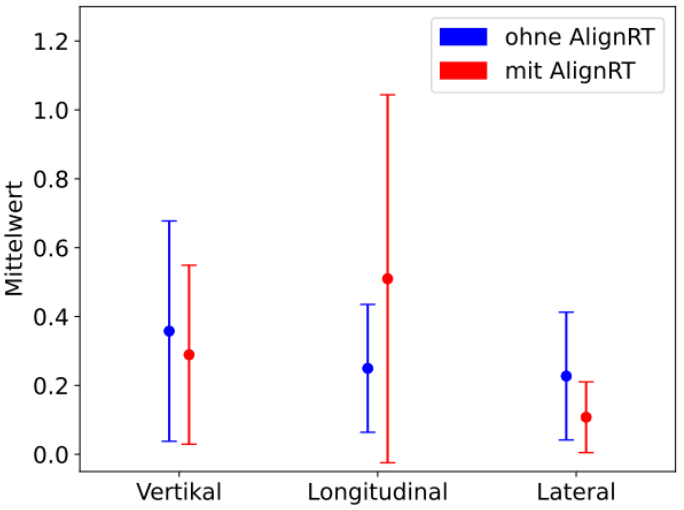
Online Matching



left Breast (DIBH)



right Breast



Prostate

→ patient position is better with AlignRT